Nano-scale Friction Force Simulation

http://info.ornl.gov/sites/rams2012/j_bachhuber

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Research objectives

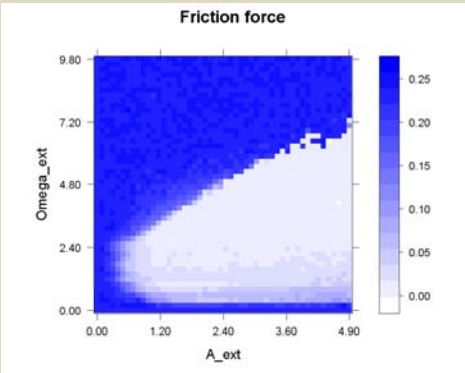
- Study friction at atomistic scale
- Reduce and ultimately control friction force by applying cantilever and/or sliding surface vibrations

Method

- Model sliding using first order ordinary differential equations (ODEs)
- Implement simulation (FORTRAN)
- Test against existing results
- Produce graphs for visualization

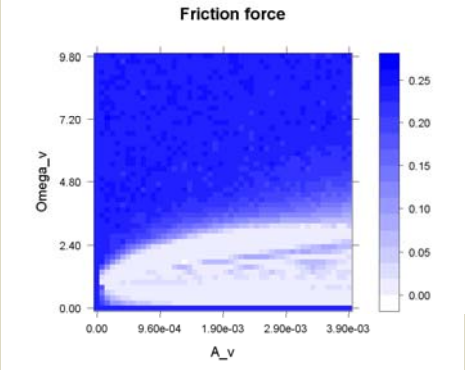
Substrate oscillations

- Axes indicate amplitude and frequency
- Darker points → higher friction force



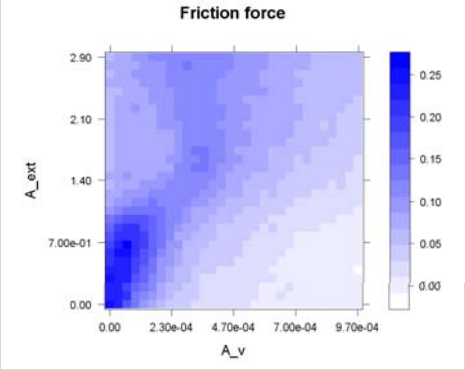
Cantilever oscillations

Similar trends as substrate oscillations



Substrate and cantilever oscillations

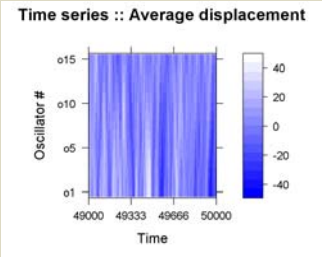
- Low amplitudes → high friction force
- Cantilever oscillation more effective
- Amplitude ratio correlated to friction force



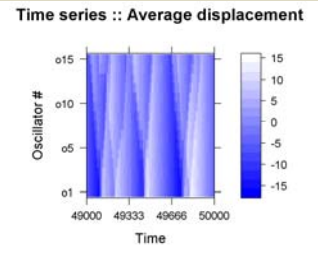
Analysis

- Higher synchrony → particles move more closely together
- Oscillations may increase synchrony in sliding system
- Synchrony correlated with lower friction force

High synchrony



Low synchrony



Conclusion

- Cantilever and surface oscillations produce similar effects
- Much smaller amplitudes suffice for cantilever vibrations → less strain on system
- Surface and cantilever oscillation combinations can provide friction force control
- Used for Atomic Force Microscopy (AFM)

[1] Jeon, S., Thundat, T., Braiman, Y. Frictional Dynamics at the Atomic Scale in presence of Small Oscillations of the Sliding Surface
[2] Guo, Y., Wang, Z., Qu, Z., Braiman, Y. Atomic-scale friction control by vibration using friction force microscope

The Research Alliance in Math and Science program is sponsored by the Office of Advanced Scientific Computing Research, U.S. Department of Energy. The work was performed at the Oak Ridge National Laboratory, which is managed by UT-Battelle, LLC under Contract No. De-AC05-00OR22725. The U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes. The author wishes to thank Dr. Yehuda Braiman, Dr. Jacob Barhen, and Debbie McCoy for guidance and advice throughout the project.